STATE OF WISCONSIN
DNR Application of DHFS Radionuclide Wastewater Disposal Criteria

For Cation and Anion Exchange Unit & Other Water Treatment Plant Wastewater Discharges Containing Naturally Occurring Radionuclides

Intent: This document is intended to be used as an information guide for Department of Natural Resources (DNR) staff, community class public water system owners, and their consultants, for explaining and applying Department of Health and Family Services (DHFS) Administrative Code HFS 157 wastewater disposal criteria for wastewater containing naturally occurring radionuclides removed from well water that will be discharged to a sanitary sewer, directly to a publicly operated treatment works (POTW), or to a surface water body. Examples of applicable wastewater types include regeneration wastewater from cation and anion exchange units, backwash wastewater from conventional and hydrous manganese oxide (HMO) filter units, and wastewaster from membrane and electrodialysis reversal (EDR) units.

Wastewater Description: Regeneration wastewater from cation exchange softeners used to remove radium and water hardness (including backwash, brining and rinse wastewater) will contain high concentrations of chlorides. Regeneration wastewater from anion exchange units used to remove nitrates and uranium will contain high concentrations of sodium. The majority of the chlorides and/or sodium and the radionuclide materials removed will be contained in the wastewater generated during the brining stage of regeneration. The wastewater chloride and/or sodium concentrations will likely exceed the allowable discharge limits for discharge to the ground surface or to a surface water body. Because of this, and because of the elevated radium and/or uranium content of the wastewater, the DNR will normally require that the regeneration wastewater from cation or anion exchange units that regenerate using sodium chloride be discharged to a sanitary sewer system.

Economics normally dictates that conventional filter backwash wastewater be disposed of to a sanitary sewer. Where sanitary sewers are not available, Wisconsin Pollution Discharge Elimination System (WPDES) permits are sometimes approved by the DNR allowing filter backwash wastewater discharges to a detention pond or to surface water provided that any necessary pretreatment of the wastewater, such as sand filtration, is provided prior to disposal. Due to the manganese and radionuclide content of the wastewater, the DNR will normally require that the wastewater from HMO filter units be discharged to a sanitary sewer system.

Due to the elevated mineral, solids and radionuclide content of the wastewater, the DNR will normally require that the brackish wastewater from membrane and EDR units be discharged to a sanitary sewer system.

In almost all of the above cases the elevated radium and/or uranium content of the wastewater will dictate that the wastewater be discharged to a sanitary sewer in order to comply with HFS 157 requirements. Where a sanitary sewer is not available the wastewater may need to be discharged to a holding tank. In such cases the wastewater will need to be periodically hauled and discharged to a DNR approved sanitary sewer receiving station or directly to the POTW.

Unity Equation: Acceptable levels of radium and uranium for discharge to a sanitary sewer or to surface water are calculated based upon the Unity Equation (see below) found in Appendix E of HFS 157. Unity Equation calculations need only be performed for wells with combined radium-226 and radium-228 and/or uranium exceeding the drinking water standards. The water system owners or their consultant must submit the Unity Equation assumptions and calculations to the DNR for review and approval before or along with, the submission of plans and specifications to the DNR for the radionculide removal equipment. The average radium-226, radium-228, and total uranium (all as applicable) assumed to be present in the wastewater will need to be calculated and inserted into the equation. Where the resultant number is less than or equal to one the proposed discharge to the sanitary sewer or surface water will be acceptable as far as the radionuclide content is concerned.

Although most of the radionuclides will be released from cation and anion resins during the brining period of regeneration, the total amount of radium and/or uranium calculated to be removed between each regeneration can be averaged over the total volume of wastewater collected for each regeneration. In the same way, the amount of radium and/or uranium removed by other water treatment processes can be averaged into the total volume of filter backwash wastewater, etc. Additionally, if needed and if helpful, s. HFS157.30 (3) allows the radionuclide content to be averaged over a 30 day period over the entire volume of process wastewater produced. The volume of other building/site wastewater released into the same sanitary sewer over the same 30 day period can also be added if needed to meet the unity equation.

Potential actions that can be taken if the result of the Unity Equation calculations is greater than one include: adding additional low radionuclide content dilution water to the wastewater, regenerating/backwashing more frequently, nonapproval by the DNR of the water treatment process as proposed, or DNR granting a variance, if applicable, based upon the dilution capabilities of the sanitary sewer/POTW wastewater collection and treatment system. If the Unity Equation cannot be successfully met, DNR staff will consult with the water system owners, their consultant, and with staff of the Radiation Protection Section (RPS) of the DHFS, before proceeding further. The installation of a wastewater holding tank prior to sanitary sewer disposal will normally not be required by DNR unless necessary to allow additional low radionuclide water to be added for blending down the average radionuclide content to acceptable levels or to prevent hydraulic overloading of the sanitary sewer.

UNITY EQUATION:

Discharges to a sanitary sewer:

(Avg. Ra-226 in pCi/l ÷ 600) + (Avg. Ra-228 in pCi/l ÷ 600) + (Avg. Total Uranium in pCi/l ÷ 3,000) ≤ 1

Discharges to surface water:

(Avg. Ra-226 in pCi/l ÷ 60) + (Avg. Ra-228 in pCi/l ÷ 60) + (Avg. Total Uranium in pCi/l ÷ 300) ≤ 1

Note: pCi/l = picocuries per liter. It is a measure of the radioactivity present in the water.

Determining average radionuclide concentrations for insertion into the equation:

All radium and uranium can be assumed to be contained in the total volume of regeneration/backwashing wastewater (total volume of backwash + brining + rinse wastewater). Also, the process radium removal efficiency for a cation exchange water softener can be assumed to be 99% (0.99).

Avg. Ra-226 (pCi/l) = [Vol. of well water treated between regeneration/backwashing (gal.) x raw water Ra-226 (pCi/l) x % process radium removal efficiency] ÷ [Total volume of regeneration/backwashing wastewater (gal.)]

Avg. Ra-228 (pCi/l) = [Vol. of well water treated between regeneration/backwashing (gal.) x raw water Ra-228 (pCi/l) x % process radium removal efficiency] ÷ [Total volume of regeneration/backwashing wastewater (gal.)]

Average Total Uranium (pCi/l) = [Vol. of water treated between regeneration/backwashing (gal.) x raw water total uranium (pCi/l) x % process uranium removal efficiency] ÷ [Total volume of regeneration/backwashing wastewater (gal.)]

Resin/Media Radioactive Content: DHFS has requested that DNR contact DHFS before DNR takes action on plans and specifications for any water treatment systems that will: a) concentrate uranium on any resin or media at any time during use (such as just prior to regeneration or just prior to disposal) to a level greater than 170 pCi/g (i.e., 170 pCi of uranium/gram of resin/media), or b) continually concentrate radium; requiring disposal of the resin or media as a low level radioactive waste. DHFS wants the opportunity to review and comment on the use, handling, and disposal of these materials, as well as the opportunity to determine if water system owners will be required to obtain a radioactive materials license for systems that continually concentrate radium. Therefore, as a part of each engineering report/plan review submittal to DNR, consultants and resin/media manufacturers will need to provide the information as applicable for either a and/or b above.

In some cases spent media may need to be handled, shipped, and disposed of as a low level radioactive waste. The RPS will need to be contacted early in the plan review process by water system owners and their consultant regarding any proposed water treatment process that may generate a low level radioactive waste. DHFS licensing will likely then be required.

DNR approval letters for the installation of radionuclide water treatment equipment will condition that the Department be contacted as to how to proceed before removing and disposing of any spent media that has been used to remove radionuclides.

Phil Fauble of the DNR's Bureau of Waste Management (608-267-3538) can be contacted regarding the disposal of spent media containing radionuclides in Wisconsin landfills. In such cases the average radionuclide content of the spent media (in pCi/g) must be known and the spent media must not be a low level radioactive waste or other material requiring DHFS licensing. DNR will contact the RPS on a case-by-case basis as necessary prior to approving any specific disposal activity.

Other Water Treatment Plant Radionuclide Concerns: There may be worker radiation and radon gas safety concerns involved when treatment vessels removing radionuclides are installed within buildings. Concerns include gamma radiation being given off from radionuclides building up on the treatment media and high levels of radon gas given off when vessel hatches are opened or regeneration/backwash wastewater is discharged with a free air break into a wastewater collection sump. Only metal vessels should be allowed for radionuclide removal treatment units, as they will provide better shielding from radioactivity than plastic. RPS staff indicates that in some cases it may be necessary to take precautions to minimize exposures to waterworks operators, especially from resins that continuously concentrate radionuclides and are then removed for disposal, and from radon gas when released into the air.

DNR approval letters will recommend that precautions be taken such as providing enhanced room air ventilation and minimizing the amount of time operators spend in rooms while units are being regenerated/backwashed.

For More Information: Norman Hahn, DNR, Bureau of Drinking Water and Groundwater (608-267-7661) and Paul Schmidt, DHFS, Chief, Radiation Protection Section (608-267-4792), can be contacted for more information regarding the information discussed in this document.

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